Unlock Energy Savings with Waste Heat Recovery

Large energy savings are available from a variety of industrial process equipment

What is Waste Heat Recovery?

Industrial Waste Heat is defined as heat generated during an industrial process that is not utilized in the process or for any other application within the facility. The heat is vented to the environment and is thus considered waste heat. Figure 1 shows a number of possible heat loss sources often found within industrial heating processes.

Waste Heat Recovery and Utilization is the process of capturing, converting, and reusing waste heat for useful purposes. Not all waste heat is practically recoverable. The amount of recoverable waste heat depends on many factors, including waste heat temperature, quantity, accessibility, quality/cleanliness, corrosiveness, and intended use. These and other factors determine the viability of waste heat recovery as a valuable no-cost, emissions-free energy resource for greater plant efficiency and energy cost savings.

Waste heat recovery processes can be classified by intended use:

Waste Heat to Heat processes utilize the recovered heat to offset other heating costs, such as process and space heating costs.

Waste Heat to Cooling and Refrigeration processes utilize heat recovered by absorption chillers or other technologies to offset other cooling or refrigeration costs.

Waste Heat to Power processes utilize the heat recovered by steam turbines, organic rankine heat engines, and other technologies to offset both electricity and other heating costs.

The economic viability of investing in heat recovery systems can be explored at a basic level by calculating the associated simple payback period:

$$\textit{Simple payback} = \frac{\textit{cost savings from avoided energy costs}}{\textit{cost of installing the waste heat recovery project}}$$

Simple payback periods of less than one year to five years are often realizable, and savings associated with productivity gains may improve the payback. In addition, project financing can often be secured, resulting in immediate financial benefits when the energy cost savings exceed (financed) project costs.

The economics can be very site specific and complicated, and a qualified specialist familiar with these systems can ensure proper calculation of benefits of waste heat recovery systems. The U.S. Department of Energy (DOE) offers a number of resources to assist facility managers with evaluation of potential benefits and payback period of a waste heat recovery system, outlined on the back of this factsheet.

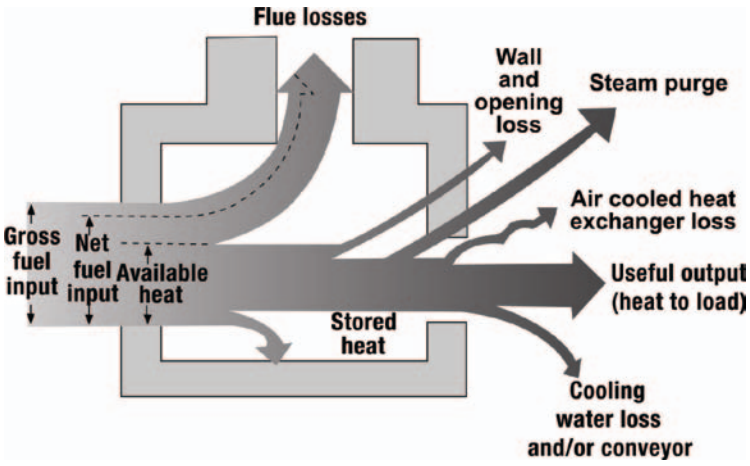

Figure 1. Heat losses in industrial heating processes

Source: Modified from Energy Efficiency and Renewable Energy (EERE). 2004."Waste Heat Reduction and Recovery for Improving Furnace Efficiency, Productivity and Emissions Performance." Washington, DC: U.S. Department of Energy. http://www1.eere.energy.gov/industry/bestpractices/pdfs/35876.pdf.

Benefits of Identifying Waste Heat Recovery Opportunities

Waste heat recovery systems offer a number of specific benefits to plants, including the following:

- Significant energy savings potential from a wide variety of industrial process heating, and steam system equipment sources including boilers, furnaces, ovens, dryers, heaters, air-cooled heat exchangers, and kilns
- Reduced energy costs (from decreased fuel and/or electricity use) and lower associated carbon dioxide emissions
- Reduced capacity and size requirements for plant thermal conversion devices such as boilers or furnaces
- Improved productivity by debottlenecking industrial processes

Gate Process to Realize Benefits

Plant managers can unlock potential waste heat recovery opportunities by utilizing the subsequent decision-making gate process. A gate process is a phased project management approach that allows each gate to serve as an evaluation point before proceeding with project implementation.

Gate 1: Techno-Economic Viability

Consider **all** waste heat streams to determine the viability of appropriate waste heat recovery systems. Specific factors to consider include the form and contents of the waste heat stream, the average waste heat temperature, any fluctuations in temperature, the degree of continuous waste heat flow, and how much energy is contained in the waste heat stream.

Resources: DOE or third-party resources and analytical tools

Gate 2: Risk Assessment and Mitigation

Determine the impact of installing the waste heat recovery system on the industrial process (e.g., evaluate the impact of an unscheduled shut down).

Resources: DOE or third-party resources and analytical tools

Gate 3: Initial Design and Economics

Present the preliminary design with several different technology alternatives from which to choose.

Gate 4: Detailed Engineering

Finalize technical specifications of the selected waste heat recovery system and ensure selected system meets project objectives.

Gate 5: Project Implementation

Install the selected waste heat recovery system.

Resources for Gates 3, 4, and 5: Partnerships with engineering companies and/or technology providers

Additional Resources

Case Studies

A number of case studies are available that illustrate waste heat recovery system benefits:

Waste Heat to Heat:

- Exhaust Heat for Oven and Holding Tank Heating Needs http://www.chpcentermw.org/pdfs/Project_Profile_Vestil_Manufacturing_062606_Final.pdf

Waste Heat to Cooling and Refrigeration:

- Ammonia Absorption Refrigeration http://www.eere.energy.gov/industry/chemicals/pdfs/p-xylene.pdf

Waste Heat to Power:

- Kennecott Utah Copper Smelter http://www.intermountaincleanenergy.org/profiles/Kennecott_Utah_Copper_Smelter-Project_Profile.pdf
- Trailblazer Pipeline Organic Rankine Cycle Technology http://www.intermountaincleanenergy.org/profiles/Trailblazer-Project_Profile.pdf

DOE Tools and Resources

Clean Energy Application Centers
http://www1.eere.energy.gov/industry/distributedenergy/racs.html

Process Heating Assessment and Survey Tool (PHAST)
http://www1.eere.energy.gov/industry/bestpractices/software_phast.html

Steam System Assessment Tool (SSAT)
http://www1.eere.energy.gov/industry/bestpractices/software_ssat.html

Tool Trainings (includes end user, qualified specialist, certified energy practitioner trainings)
http://www1.eere.energy.gov/industry/bestpractices/training.html

Qualified specialists (who can carry out plant assessments)
http://www1.eere.energy.gov/industry/bestpractices/qualified_specialists/

Studies

1. "Waste Heat Recovery: Technology and Opportunities in U.S. Industry" details the state of waste heat recovery technologies and evaluates R&D needs for improving these technologies (March 2008). http://www1.eere.energy.gov/industry/intensiveprocesses/pdfs/waste_heat_recovery.pdf
2. "Opportunity Analysis for Recovering Energy from Industrial Waste Heat and Emissions" provides an overview of industrial emissions and waste heat recovery opportunities (April 2006). http://www1.eere.energy.gov/industry/imf/pdfs/4_industrialwasteheat.pdf
3. "Using Waste Heat for External Processes" provides useful information needed to help evaluate the use of waste gases for heating secondary processes (January 2006). http://www1.eere.energy.gov/industry/bestpractices/pdfs/38853.pdf
4. "Use Feedwater Economizers for Waste Heat Recovery" assists with the installation of a feedwater economizer to reduce steam boiler fuel requirements by transferring flue gas heat to incoming feedwater (January 2006). http://www1.eere.energy.gov/industry/bestpractices/pdfs/steam3_recovery.pdf
5. "Waste Heat Reduction and Recovery for Improving Furnace Efficiency, Productivity and Emissions Performance" details methods to maximize efficiency and productivity from industrial furnaces through equipment energy conservation techniques and waste heat recovery (November 2004). http://www1.eere.energy.gov/industry/bestpractices/pdfs/35876.pdf
6. "Use Low-Grade Waste Steam to Power Absorption Chillers" outlines the benefits of absorption chillers (which can utilize low-grade waste heat) to replace motor-driven mechanical chillers (January 2006). http://www1.eere.energy.gov/industry/bestpractices/pdfs/steam14_chillers.pdf
7. "Refractories for Industrial Processing: Opportunities for Improved Energy Efficiency" describes the different applications of refractories in U.S. industry, as well as possible R&D pathways for overcoming refractory-related performance barriers (January 2005). http://www1.eere.energy.gov/industry/imf/pdfs/refractoriesreportfinal.pdf
8. "Unlocking Energy Efficiency in the U.S. Economy" describes approaches to greater energy efficiency in the U.S. industrial sector (July 2009). http://www.mckinsey.com/en/Client_Service/Electric_Power_and_Natural_Gas/Latest_thinking/Unlocking_energy_efficiency_in_the_US_economy.aspx
9. "Energy Use, Loss and Opportunities Analysis: U.S. Manufacturing & Mining" describes the U.S. industrial sector and details the top opportunities for industrial energy savings, including several waste heat recovery opportunities (December 2004). http://www1.eere.energy.gov/industry/intensiveprocesses/pdfs/energy_use_loss_opportunities_analysis.pdf

For additional information, please contact

Bill Orthwein, CEM
Technology Manager
Industrial Technologies Program
U.S. Department of Energy
E-mail: william.orthwein@ee.doe.gov
(202) 586-3807

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